THE EFFECTS OF INSTRUCTIONS, DISTANCE, AND LEARNING ON THE NUMBER OF FLUCTUATIONS OF THE WHEATSTONE-NECKER CUBE

A Thesis

Presented to

The Graduate Division

Drake University

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

---

by

James Franklin Thomas

January 1964

1964
T364

1677
J3

THE EFFECTS OF INSTRUCTIONS, DISTANCE, AND LEARNING ON THE NUMBER OF FLUCTUATIONS OF THE WHEATSTONE-NECKER CUBE

by

James Franklin Thomas

Approved by Committee:

Anthony C. Winterhof
Chairman

Howard McGinnies

Lee Deppert

E. C. Carroll
Dean of the Graduate Division

TABLE OF CONTENTS

CHAPTER		PAGE
I.	FLUCTUATIONS OF PERSPECTIVE	1
II.	OVERVIEW OF THE PROBLEM	11
III.	METHOD	14
IV.	RESULTS OF EXPERIMENT	17
V.	DISCUSSION	33
VI.	SUMMARY AND CONCLUSIONS	36
BIBLIOGRAPHY		37

LIST OF TABLES

TABLE PAGE

I. Wheatstone-Necker Cube Fluctuation Rate Study, Means and Sigmas for the 25 Male Subjects under Two Sets of Instructions 18

II. Wheatstone-Necker Cube Fluctuation Rate Study, Means and Sigmas for the 25 Female Subjects under Two Sets of Instructions 19

III. Wheatstone-Necker Fluctuation Rate Study, Analysis of Variance for the Men 20

IV. Wheatstone-Necker Fluctuation Rate Study, Analysis of Variance for the Women 21

V. Analysis of Variance Model for the Men from the Wheatstone-Necker Fluctuation Rate Study 22

VI. Analysis of Variance Model for the Women from the Wheatstone-Necker Fluctuation Rate Study 24

LIST OF FIGURES

FIGURE PAGE

1. Wheatstone-Necker Fluctuation Rate Study. The Distance Times Instructions Interaction for the Women 26

2. Wheatstone-Necker Fluctuation Rate Study. The Distance Times Learning Times Instruction Interaction for the Men . . 27

3. Wheatstone-Necker Fluctuation Rate Study. The Distance Times Learning Times Instruction Interaction for the Women 28

4. Wheatstone-Necker Fluctuation Rate Study. The Effect of Sex with Order and Instructions Combined 29

5. Wheatstone-Necker Fluctuation Rate Study. The Effect of Instructions with Sex and Order Combined 30

6. Wheatstone-Necker Fluctuation Rate Study. The Effect of Order with Instructions and Sex Combined 31

CHAPTER I

FLUCTUATIONS OF PERSPECTIVE

This study examined the effects of distance, instructional set, and learning sequence on the fluctuation rate of the Wheatstone-Necker Cube.

When outline drawings of three-dimensional solid figures are presented, as in geometry texts, the faces of the figures may appear to interchange. That is, the face which was at first background, is seen as foreground and vice versa. Such interchanges have been variously termed "changes," "reversals," or "fluctuations," of perspective.

According to Boring,[1] the Swiss naturalist Necker was the first person to call attention to the phenomenon of reversible perspective. Necker, in a letter in 1832, described the "optical phenomenon which occurs upon viewing a crystal or a geometrical solid." Necker noted that the change could be controlled by fixation on the inner corners of the figure.

Lange and Marbe, working in Wundt's laboratory, attempted to relate changes in perspective to fluctuations in attention. Flugel[2]

---

[1] E. G. Boring, Sensation and Perception in the History of Experimental Psychology (New York: D. Appleton-Century Company, 1942).

[2] J. C. Flugel, "The Influence of Attention in Illusions of Reversible Perspective," British Journal of Psychology, V (1913), 357-397.

measured reversal rates and found that the perspective was influenced by the focal point of attention. Philpott[1] found the fluctuations increased as fatigue increased. These early findings seemed so vague that not much has been done with them.

A great deal of impetus to research with fluctuations of perspective was presented by the 1926 views of McDougall.[2] His findings can be summarized in three major conclusions. First, his results indicated that "introverted" subjects experienced more rapid fluctuations than "extroverted" subjects. He hypothesized this difference to be the result of a secretion which increased synaptic resistance in the cortex. Secondly, he measured the effects of alcohol and other drugs on these fluctuations of perspective. Alcohol was alleged to produce extrovertive behavior. The third major conclusion was that the fluctuation rates of dementia praecox patients should average higher than the rates of manic-depressive patients.

For the most part, tests of McDougall's ideas have led to contradictory results. The early researches were hampered by poor tests of introversion-extroversion. In some cases reliance was placed on ratings for this dimension of personality. In any event, the historical

---

[1] S. J. Philpott, "Fluctuations in Human Output," British Journal of Psychology, XIV-XIX (1932), 5-125.

[2] W. McDougall, Outline of Abnormal Psychology (New York: Scribner's and Sons, 1926).

researches illuminated the factors which need to be controlled in this type of perceptual research.

To test the introversion-extroversion hypothesis, Guilford and Braly[1] tested twenty male subjects ranging in age from eighteen to twenty-three years of age. The Marston Personality Rating Scale and the Neymann-Kohlstedt test were used to determine introversion scores. The cube was used as the stimulus, and a telegraph key signaled the changes. The instructions were not stressed, which meant that the subjects were told not to try to control the fluctuations. Three minutes of observations were alternated with three minutes of rest until twenty-one observations were recorded.

The rate of fluctuation was found to be constant for the same person throughout the hour of testing. The experimenters concluded that the rate of fluctuation is a highly reliable measure of some psychological function. However, little in common between this function and the introversion-extroversion scores was found. Some additional testing indicated that alcohol had no consistent influence on fluctuation rate, but there was a slight tendency toward rate increase.

Guilford and Frederiksen[2] found little relationship between

---

[1] J. P. Guilford and K. W. Braly, "An Experimental Test of McDougall's Theory of Extroversion-Introversion," Journal of Abnormal and Social Psychology, XXV (1931), 382-389.

[2] J. P. Guilford and N. O. Frederiksen, "Personality Traits and Fluctuations of the Outline Cube," American Journal of Psychology, XXXXVI (1934), 470-474.

introversion-extroversion scores and fluctuation rate. They believed that the inconsistent paper and pencil tests of introversion-extroversion were a major obstacle to research. In their experiment therefore, two "associate ratings" and one "self-rating" were obtained as the criterion measures for introversion-extroversion. In other words, each subject rated himself and was rated by two of his associates. The cube was observed for thirty minutes a day for three days, and the number of changes per minute were taken as the fluctuation rate. The subjects were instructed to take a passive attitude. Using self-ratings alone the correlation was only .047± .070 and with both self-ratings and associate ratings it was .060± .070. No single items correlated with fluctuation rate.

One year later the Nebraska Personality Inventory was constructed. Hoffeditz and Guilford[1] attempted to relate fluctuations of perspective to Social Introversion scores obtained from this scale. Rates of fluctuation and duration of phase were obtained by the use of a telegraph key. Each stimulus figure was observed for two minutes on three different days. There were twenty-four subjects, twelve men and twelve women. The reliabilities obtained were high and the average rate of fluctuations ranged from three to eighty-three per minute. The rates correlated significantly with scores obtained on this inventory. These experimenters

---

[1] E. L. Hoffeditz and J. P. Guilford, "The Factors Present in the Fluctuations of Fifteen Ambiguous Phenomena," Psychology Bulletin, XXXII (1935), 726-727.

reported that the outline cube possessed the most reliability on retest and yielded the least ambiguous reversal scores.

George[1] employed a rating scale to measure introversion-extroversion, and also sought the effect of sex differences, and various stimulant and anaesthetic drugs on the rate of fluctuations. Eighty-six subjects observed three figures: the windmill, Rubins black and white cross, and Jastrow's cube illusion. He obtained results showing a significant correlation between fluctuation rates and rating scale for introversion-extroversion. Sodium amytal, a depressant, significantly increased them. This effect of caffein lent support to McDougall's earlier theory on the influence of alcohol.

The results of George's experiment in regard to the relationship between fluctuations of perspective and rating scores of introversion-extroversion are contradictory to those of Guilford and Frederiksen. The findings with regard to the effects of drugs have not been further investigated.

McDougall's notion in regard to categories of mental illness and fluctuation rates has fared no better in research. Hunt and Guilford[2]

---

[1] R. W. George, "The Significance of the Fluctuations Experienced in Observing Ambiguous Figures and in Binocular Rivalry," Journal of General Psychology, XV (1936), 39-61.

[2] J. McV Hunt and J. P. Guilford, "Fluctuation of an Ambiguous Figure in Dementia Praecox and in Manic Depressive Patients," Journal of Abnormal and Social Psychology, XXVII (1932), 443-452.

investigated fluctuation of perspective in nineteen manic-depressive patients and twenty-six dementia praecox patients. All but three persons were tested in one day, with "hold" and "free" instructions given alternately. Subjects were told to try to prevent fluctuations for the "hold" instruction and to attempt no control for the "free" instruction. The patients were not used if proper rapport could not be established or if the patient could not see the "shift."

The average rates for the dementia praecox patients were four times that of manic depressive patients under passive instructions, and six times greater under inhibitive instructions. The rates were constant from day to day, with dementia praecox patients showing more variation. The experimenters believed that the inhibition shown in manic-depressive insanity caused the rate difference. They further hypothesized that only one aspect of introversion-extroversion which is a composite trait was measured. The measured aspect is one in which the dementia praecox does not deviate from the normal but in which the manic depressive does. They called this aspect the "tendency to objectify experience."

A similar experiment by Nemor[1] investigated the relationship of the perception of the fluctuations of the Necker Cube to pathology in the central nervous system. This study was based on the hypothesis that disturbances in brain physiology, attendant upon gross organic

---

[1]N. Nemor, "The Alternation of an Ambiguous Figure in Paretics and Schizophrenics," Journal of Abnormal and Social Psychology, XXXXVIII (1953), 445-446.

pathology, result in lowered frequency of alternations. Seventeen patients with known gross C.N.S. (psychosis, general paresis, cerebral type) pathology and twenty-two with no known organic pathology (schizophrenics, psychotics) were tested. The groups were roughly matched on age and length of illness. These two groups were compared with the two groups tested by Hunt and Guilford. Contrary to the Hunt and Guilford findings, no significant differences in the number of fluctuations were found between groups.

While these investigations were taking place, other experimenters were attempting to uncover explanations for the fluctuations of perspective. Wheatstone, Oppel, and Schroeder attributed the fluctuation to imagination, judgment, and will. Necker, Brewster and Wundt ascribed the fluctuation to response changes in the visual system. They felt that eye movements and changes in fixation were causative factors. Zimmer[1] reported that the subject tended to fixate that part of the figure which was nearest him. He also reported that eye movement occurred about a second after the reversal of perspective was perceived.

The eye movement explanation became more complicated after the study of Washburn and Gillette[2] with colored fields and retinal rivalry.

---

[1]R. S. Woodworth and H. Schlosberg, Experimental Psychology (New York: Henry Holt and Company, 1956).

[2]M. F. Washburn and A. Gillette, "Motor Factors in Voluntary Control of Cube Perspective Fluctuations and Retinal Rivalry Fluctuations," American Journal of Psychology, XXXXV (1933), 315-319.

Thirty-five women were shown a white line on a black background cube drawing. With the use of a stereoscope blue and red squares were shown. This test was designed to test the degree to which the subject could "hold" the cube in one position or one of the colored cubes in the visual field. The white cube condition was superior to the color rivalry condition. The authors stated that "the actual movement of the eye-shift of fixation" accounted for these results. They suggested that no other causal factors operated except the familiar ones of interaction and interference of movements.

Previous to Washburn and Gillette's work, Mull, Arp, and Carlin[1] obtained results supporting a "central" explanation of fluctuations. They found that individuals maintain similar rates with one or two eyes in spite of differences in eye strength. It was postulated from this that the better control by more intelligent subjects pointed toward "central" coordination.

Taking somewhat of an intermediate position, Sisson[2] agreed that the shifting appearance is due to central factors and that eye movements depend upon the shifting experience. He found that 33 per cent of eye movements were followed by fluctuations. Forty-six per cent of the fluctuations were followed by eye movements. Sisson, therefore, like

---

[1] H. K. Mull, K. Arp, and P. Carlin, "Indication of a Central Factor in Uncontrolled and Controlled Shifts in Cube Perspective," American Journal of Psychology, LV (1952), 89-90.

[2] Woodworth and Schlosberg, op. cit.

Zimmer, concluded that central factors play a significant role in influencing fluctuations.

Mull, Ord, and Locke[1] in a later investigation on the effects of brightness among contour, background, and illumination were able to specify their central factor as a motor factor. The Necker Cube was used as a stimulus because it furnished changes defined more sharply than any other figure. Thirty-six students in six groups were the subjects. The stimuli were a two-inch cube shown (1) on a white ground with 200 watt illumination, (2) on a medium gray ground with 200 watts, and (3) on a white ground with 15 watts. The rate of fluctuation was not influenced by either the difference in amount of illumination or of contrast, and neither stimulus was more effective than the other.

These results furnish evidence against a single process of the visual center, such as "blocking," which depends upon sensory conditions. From these findings the authors postulated a "motor" factor, which explains the ineffectiveness of differences in stimulus, such as illumination and contrast. The irregularity and lack of uniformity of rates of fluctuation were also attributed to this "motor" factor. Hence, these experimenters are basically in agreement with the motor views earlier expressed by Washburn and Gillette.

A direct attack on the eye movements notion was attempted by

---

[1] H. K. Mull, N. Ord, and N. Locke, "The Effect of Two Brightness Factors upon the Rate of Fluctuation of Reversible Perspectives," American Journal of Psychology, LXVII (1954), 341-342.

Glen,[1] who studied the relationship between eye movements and reversible perspective. He devised a complex photographic apparatus which was able to record the most delicate movements of the eye. This relationship was affected by the complexity of the task or motor response used in objectively reporting the reversals. It was least apparent whenever the instructions included references made to the actual eye movements. These results indicate that central factors affect both eye movement and fluctuation rate.

The scarcity of well controlled experimentation on fluctuations is immediately evident. What generalizations have been made can be seen to have been based on a few poorly controlled investigations. Cube fluctuations continue to appear as a test of rigidity in personality. Little organized systematic work to tease out the factors which control the fluctuations have been attempted. This study reports such an attempt. The major variable is the effect of distance on the number of reversals obtained under free and hold conditions.

---

[1] J. S. Glen, "Ocular Movements in Reversibility of Perspective," Journal of General Psychology, XXIII (1940), 243-281.

CHAPTER II

OVERVIEW OF THE PROBLEM

The reversible figures have long been considered a crucial signpost on the road to understanding the most central mechanisms controlling perception.[1] Little has been done on controlled and systematic experimentation. Much of the developed theory has involved motor and central factors which are too broad to be meaningful.

This investigation was concerned with the effect of "free" and "hold" instructions on the number of fluctuations of a reversible figure as a function of distance. The experimental design was replicated in that both samples of men and women were used in separate experiments.

A review of the literature suggests several control factors. One is the use of cube as the best reversible perspective stimulus. Hoffeditz and Guilford[2] found the cube to be the most reliable on retesting and yielding the least ambiguous reversal scores. Mull, Ord, and Locke[3] found that the Necker Cube furnished changes defined more sharply than any other figure.

Three of the factors which have been shown to affect the rate of fluctuations of reversible figures are: fatigue, presence of a

---

[1] J. S. Bruner, L. Postman and F. A. Mosteller, "Notes on the Measurement of Reversals of Perspective," Psychometrika, XV (1950), 63-72.

[2] Hoffeditz and Guilford, loc. cit.

[3] Mull, Ord and Locke, loc. cit.

fixation point, and the type of set used in handling the signal key to report the fluctuations. Since both Necker[1] and Zimmer[2] indicated that a fixation point decreased the number of fluctuations, none was provided in this experiment. Glen[3] eliminated the signal key and discovered the complexity of the motor response used in reporting the reversals. Hence, the omission of a signal key seemed to be indicated.

Previous experimentation has indicated that thirty-second trials would offer the subject the best control over eye blinks. To insure reliability, the subjects counted the number of reversals under free and hold instructions in the counterbalanced order: free, hold, hold, free. The two free and the two hold thirty-second scores were summed to obtain the two respective scores at each of the viewing distances.

The counterbalanced trial at each of the five viewing conditions left a learning or sequence factor uncontrolled. It was hoped that with adequate practice previous to the investigation, subjects would be operating at approximately the same areas of their learning curves. Furthermore, the use of a Latin-square design made possible the computation of a variance due to sequence or learning during the experimental trials. The variance due to learning could be evaluated along with the other factors.

Assumptions underlying the Latin-square refer to the distribution of residuals after each effect is removed from the table. These assumptions are: normality of the distribution of scores within each cell,

---

[1]Boring, op. cit. [2]Woodworth and Schlosberg, op. cit.

[3]Glen, loc. cit.

homogeneity of variance among cells of the table, equal correlation between conditions involving repeated measurements, and homogeneity of the levels of the various variables.[1] Although checking these assumptions involves a great deal of labor, the methods for checking are themselves rather approximate. The analysis of variance is a robust technique and these checks seldom need to be carried out. Certain approximate checks on some of these assumptions were made during the course of the data analysis.

---

[1] B. J. Wimer, Statistical Principles in Experimental Design (New York: Henry Holt and Company, 1956).

CHAPTER III

METHOD

Fifty volunteer subjects, twenty-five males and twenty-five females, were recruited from beginning psychology courses at Drake University. Subjects were required to meet three selection criteria: (1) be between the ages of eighteen and twenty-two years, (2) not suffer from any eye difficulties, and (3) not wear glasses. The median age of all subjects was twenty years. With regard to classification, fourteen were freshmen, thirty were sophomores, and six were juniors.

The apparatus employed was a black India-ink drawing on a white background of the Wheatstone-Necker Cube. The basic squares were ten inches on each side. One square was offset from the top and from the left side by three inches. Hence, the diagonals had a negative slant. The drawing was centered on a cardboard background 19.5 by 23 inches.

Five chairs were placed at distances of 5, 10, 15, 20, and 25 feet from the cube drawing. Chair one was situated five feet from the stimulus and the other four chairs at distances of 10, 15, 20 and 25 feet, respectively. These were measured out in the beginning and tacks placed in floor to insure constancy.

The subjects were tested in groups of five. Each subject was welcomed to the laboratory and asked to sit in one of the five chairs corresponding to the different viewing distances. Each subject

practiced with the cube until he was able to see it fluctuate. Those who were not able to see it fluctuate immediately were given additional instructions.

Subjects operated under two conditions of instruction at each distance: hold (H), and free (F). When the experimenter desired inhibited fluctuation, subjects were instructed to try to hold the cube in only one position throughout the length of the thirty-second trial. When free fluctuation was desired, subjects were instructed to let the cube fluctuate freely but not to force it. Subjects were asked to blink during the rest period but not during the trials. Each subject was asked to hold his head in only one position during all trials by resting it on his right arm which was propped up on the arm of the viewing chair.

Subjects proceeded in random order, to each of the five viewing distances: 5, 10, 15, 20 and 25 feet with reference to the cube drawing. They counted the number of fluctuations silently under the two sets of instructions at each of the five viewing distances. Subjects viewed the cube for a total of two minutes at each distance, thirty seconds being spent under each of the instructional conditions. The order at each viewing position was free, hold, hold, free. The number of fluctuations experienced under each set of conditions at each distance was recorded by subjects on a scoring sheet provided by the experimenter.

The two thirty-second free scores and the two thirty-second hold scores were combined to yield one minute free and hold scores. To meet

the assumptions underlying the analysis of variance technique, these scores were transformed by means of the Tukey-Freeman transformation.

The design of the experiment was a mixed Latin square-Lindquist Type IV.[1] Two separate analyses were carried out, one for the male subjects and one for the female subjects. As a partial check on the assumptions underlying the analyses of variance tables for each of the separate error terms in the analyses were studied. Within each of these tables, variances were computed for each cell, and homogeneity was tested using the Cochran test.[2] This test is admittedly rough in that it was carried out on the raw scores rather than on the residuals in each table. However, since under this circumstance only a few of the tests exceeded the 5 per cent level and none the 1 per cent level, the conclusion that the F tests would probably be valid was in order. Nor, at this point, was there any indication that the correlations between the repeated measures, or that the variances across the levels of the variables, were in any way highly discrepant.

---

[1] H. F. Lindquist, Design and Analysis of Experiments in Psychology and Education (Boston: Houghton Mifflin Company, 1953).

[2] W. J. Dixon and F. J. Massey, Jr., Introduction to Statistical Analysis (second edition; New York: McGraw Hill, 1957), pp. 438-439.

CHAPTER IV

RESULTS OF EXPERIMENT

This experiment was conducted in an effort to assess the effects of several stimuli which influence the rate of fluctuation of the Wheatstone-Necker Cube. The stimuli were instructions, distance and the sequence of trials or learning.

Twenty-five men and twenty-five women, ages eighteen to twenty-one, viewed a drawing of a cube at five distances under two sets of instructions. The means and variances for each condition are presented in Tables I and II. Means for the men varied between 5.12 and 11.80, with estimated standard deviations between .17 and 1.68. The means for the women varied between 5.22 and 9.81, with estimated standard deviations between .20 and 1.62. The grand mean for the men was 7.85 and the grand mean for the women was 7.38.

Tables III and IV present results of the analysis of variances for the men and women. For men distance (D), instructions (I), and distance times learning times instructions (DxIxL) are significant beyond the 1 per cent level. Since the distance times learning times instructions (DxLxI) interaction is the highest order interaction, caution in generalizing these results beyond the present experiment is indicated.

Table IV presents the results for the women. Distance (D) is significant only at the 5 per cent level. The distance times learning

TABLE I

WHEATSTONE-NECKER CUBE FLUCTUATION RATE STUDY, MEANS AND SIGMAS FOR THE 25 MALE SUBJECTS UNDER TWO SETS OF INSTRUCTIONS

Order	5'		10'		15'		20'		25'	
	Free	Hold	Free	Hold	Free	Hold	Free	Hold	Free	Hold
20', 5', 15', 10', 25'										
Mean	8.25	6.85	8.97	6.18	9.04	6.97	9.00	7.81	9.22	6.71
S.D.	1.45	.98	1.33	.68	1.05	.65	1.68	.90	1.25	.75
25', 10', 20', 15', 5'										
Mean	7.58	5.64	7.87	5.72	7.74	5.38	8.06	6.20	8.64	6.48
S.D.	.62	.95	.51	1.44	.64	1.33	.30	.92	.22	.71
15', 20', 5', 25', 10'										
Mean	8.49	7.37	8.63	6.96	9.71	6.90	9.47	7.42	9.42	7.29
S.D.	.76	.63	.55	.51	.82	.69	.79	.64	.79	.88
10', 15', 25', 5', 20'										
Mean	6.51	5.12	7.83	5.27	7.87	7.08	8.49	6.69	8.26	7.26
S.D.	1.17	.65	.48	.45	.51	.46	.24	.37	.17	.40
5', 25', 10', 20', 15'										
Mean	10.84	6.77	11.80	7.11	11.68	7.50	11.07	7.02	10.49	7.72
S.D.	1.46	.55	1.17	1.24	1.11	.88	1.34	.84	1.40	.85

TABLE II

WHEATSTONE-NECKER CUBE FLUCTUATION RATE STUDY, MEANS AND SIGMAS FOR THE 25 FEMALE SUBJECTS UNDER TWO SETS OF INSTRUCTIONS

Order	5'		10'		15'		20'		25'	
	Free	Hold	Free	Hold	Free	Hold	Free	Hold	Free	Hold
20', 5', 15', 10', 25'										
Mean	8.33	6.96	9.12	7.38	9.18	7.65	8.72	7.38	9.49	7.87
S.D.	.66	.47	.59	.30	.39	.58	1.04	.60	1.11	.71
25', 10', 20', 15', 5'										
Mean	8.79	6.86	8.66	5.96	9.51	6.26	9.13	6.39	8.50	5.80
S.D.	.50	.40	.42	.52	.91	.33	.56	.61	.20	.33
15', 20', 5', 25', 10'										
Mean	7.59	5.34	8.04	6.27	9.81	7.23	8.27	6.01	7.80	6.79
S.D.	1.62	.69	1.38	.58	1.14	.88	1.41	1.45	1.44	.67
10', 15', 25', 5', 20'										
Mean	7.21	5.22	7.48	6.25	6.88	5.99	7.08	5.31	6.62	6.33
S.D.	.33	.77	.39	.63	.58	.65	.45	.22	.41	.57
5', 25', 10', 20', 15'										
Mean	7.58	6.38	8.44	6.91	8.48	6.07	8.27	5.84	8.13	7.30
S.D.	1.18	.80	1.06	.45	1.38	.79	1.11	.67	1.10	1.11

TABLE III

WHEATSTONE-NECKER FLUCTUATION RATE STUDY,
ANALYSIS OF VARIANCE FOR THE MEN

Source	Results	Degrees of Freedom	Mean Square	F
Subjects	493.78	24		
Orders (O)	171.84	4	42.96	2.67(4/20) N.S.
Error (b)	321.94	20	16.10	
Within	768.38	225		
Distance (D)	24.35	4	6.09	4.76(4/80)**
Learning (L)	2.96	4	.74	
D·L	19.48	12	1.62	1.26(12/80) N.S.
Error (W_1)	102.65	80	1.28	
Instructions (I)	330.83	1	330.83	41.72(1/20)**
O·I	45.06	4	11.26	1.42(4/20) N.S.
Error (W_2)	158.50	20	7.93	
D·I	4.84	4	1.21	1.48(4/80) N.S.
L·I	3.64	4	.91	1.10(4/80) N.S.
D·L·I	182.30	12	15.19	18.52(12/80)**
Error (W_3)	65.61	80	.82	
Total	1262.16	249		

**Significant at or beyond the 1 per cent level.

TABLE IV

WHEATSTONE-NECKER FLUCTUATION RATE STUDY,
ANALYSIS OF VARIANCE FOR THE WOMEN

Source	Results	Degrees of Freedom	Mean Square	F
Subjects	415.44	24		
Orders (O)	81.12	4	20.28	1.21(4/20) N.S.
Error (b)	334.32	20	16.72	
Within	499.57	225		
Distance (D)	13.08	4	3.27	3.03(4/80)*
Learning (L)	3.75	4	.94	
D·L	23.42	12	1.95	1.80(12/80) N.S.
Error (W_1)	86.47	80	1.08	
Instructions (I)	204.92	1	204.92	40.34(1/20)**
O·I	14.84	4	3.71	
Error (W_3)	101.53	20	5.08	
D·I	5.81	4	1.45	3.30(4/80)*
L·I	1.02	4	.25	
D·L·I	90.41	12	7.53	17.11(12/80)**
Error (W_2)	35.43	80	.44	
Total	915.01	249		

*Significant at or beyond the 5 per cent level.
**Significant at or beyond the 1 per cent level.

TABLE V

ANALYSIS OF VARIANCE MODEL FOR THE MEN FROM THE WHEATSTONE-NECKER FLUCTUATION RATE STUDY

Order	Subject	5'		10'		15'		20'		25'	
		Free	Hold	Free	Hold	Free	Hold	Free	Hold	Free	Hold
41325	1	3.73	3.73	5.10	5.83	6.78	6.16	6.48	4.69	7.35	6.78
	2	11.22	7.87	11.92	6.16	10.68	7.61	12.88	8.83	11.58	7.35
	3	8.83	6.16	10.30	5.83	9.90	5.47	11.04	8.60	10.30	5.10
	4	7.35	7.87	7.61	4.69	6.78	6.78	4.69	7.87	5.83	5.47
	5	10.10	8.60	9.90	8.37	11.04	8.83	9.90	9.05	11.04	8.83
52431	6	8.37	8.12	9.49	8.83	9.05	8.12	8.37	7.35	8.83	8.60
	7	7.61	4.69	8.12	5.83	9.05	5.47	8.60	6.16	9.05	6.78
	8	5.47	3.15	6.78	1.00	7.07	1.00	7.07	3.15	8.60	4.69
	9	8.60	6.78	7.35	6.48	6.16	6.48	8.37	7.87	7.87	6.16
	10	7.87	5.47	7.61	6.48	7.35	5.83	7.87	6.48	8.83	6.16
34152	11	9.05	8.37	9.05	7.35	10.68	4.69	10.86	6.78	9.90	7.07
	12	9.27	8.37	9.05	8.37	9.27	7.61	10.10	9.27	9.27	9.27
	13	5.83	5.83	6.78	6.16	7.07	8.12	6.78	5.83	6.78	5.10
	14	8.83	8.12	9.69	7.07	11.22	7.61	9.49	7.87	10.49	8.83
	15	9.49	6.16	8.60	5.83	10.30	6.48	10.10	7.35	10.68	6.16
23514	16	7.87	6.16	7.61	6.48	8.83	8.12	8.60	7.07	8.83	8.37
	17	6.78	4.69	7.61	4.24	8.60	6.16	8.12	6.48	8.12	6.16
	18	2.41	3.73	7.07	5.10	6.78	7.87	7.87	7.07	8.37	7.61
	19	7.87	6.78	7.35	5.83	8.37	6.16	8.83	7.35	8.12	7.07
	20	7.61	4.24	9.49	4.69	6.78	7.07	9.05	5.47	7.87	7.07

TABLE V (continued)

Order	Subject	5' Free	5' Hold	10' Free	10' Hold	15' Free	15' Hold	20' Free	20' Hold	25' Free	25' Hold
15243	21	14.49	5.47	13.34	3.73	13.34	5.47	12.73	4.69	7.61	6.48
	22	9.27	7.07	9.27	7.07	9.05	7.35	10.68	8.12	10.30	7.61
	23	13.49	6.78	14.49	8.12	14.21	6.16	14.21	7.87	14.35	8.60
	24	8.12	8.37	12.41	10.49	11.92	9.49	10.68	8.60	12.08	10.10
	25	8.83	6.16	9.49	6.16	9.90	9.05	7.07	5.83	8.12	5.83

TABLE VI

ANALYSIS OF VARIANCE MODEL FOR THE WOMEN FROM THE WHEATSTONE-NECKER FLUCTUATION RATE STUDY

		5'		10'		15'		20'		25'	
Order	Subject	Free	Hold	Free	Hold	Free	Hold	Free	Hold	Free	Hold
41325	26	9.05	7.35	8.83	7.87	8.83	6.78	8.12	6.16	8.83	5.83
	27	6.78	6.78	7.87	7.87	7.35	8.37	7.07	8.12	10.10	9.49
	28	8.37	8.37	9.69	7.61	10.10	9.05	9.27	6.48	10.10	8.60
	29	7.35	6.16	8.37	7.07	7.87	7.87	7.07	7.07	6.16	7.07
	30	10.10	6.16	10.86	6.48	11.75	6.16	12.08	9.05	12.25	8.37
52431	31	9.05	6.16	9.49	5.83	11.04	6.78	9.90	6.48	8.37	5.47
	32	7.61	5.83	9.05	6.16	10.10	6.16	10.10	5.83	8.12	5.47
	33	8.37	7.35	7.35	6.78	6.78	5.47	7.35	7.07	8.12	6.16
	34	10.30	7.61	9.05	4.24	11.04	5.83	8.83	4.69	8.83	5.10
	35	8.60	7.35	8.37	6.78	8.60	7.07	9.49	7.87	9.05	6.78
34152	36	5.83	4.24	7.87	5.83	9.27	7.61	8.37	7.61	6.16	6.78
	37	13.04	7.35	12.73	7.87	13.19	8.83	12.41	7.61	12.57	7.35
	38	5.47	4.24	5.47	4.69	6.78	4.24	4.69	1.00	5.10	4.69
	39	5.47	4.69	6.78	6.48	9.90	8.12	7.07	7.87	8.12	8.37
	40	8.12	6.16	7.35	6.78	9.90	7.35	8.83	6.16	7.07	6.78
23514	41	6.16	7.61	7.07	7.07	7.61	7.87	6.48	5.47	7.07	6.78
	42	7.61	4.24	7.07	5.47	5.83	5.83	7.35	4.69	5.47	5.83
	43	7.87	5.83	8.83	6.16	8.12	6.16	7.87	5.47	7.61	5.47
	44	7.07	4.69	7.07	7.87	5.47	5.83	5.83	5.83	6.78	8.12
	45	7.35	3.73	7.35	4.69	7.35	4.24	7.87	5.10	6.16	5.47

TABLE VI (continued)

Order	Subject	5' Free	5' Hold	10' Free	10' Hold	15' Free	15' Hold	20' Free	20' Hold	25' Free	25' Hold
15243	46	9.05	7.87	9.69	7.87	10.10	6.78	9.05	6.78	9.69	7.61
	47	10.49	8.37	11.22	7.61	12.57	8.37	11.22	7.35	11.22	10.86
	48	4.24	5.10	5.83	7.07	6.16	4.24	6.78	4.24	6.78	7.07
	49	7.07	5.47	8.37	6.16	6.78	5.47	8.83	6.16	6.48	5.47
	50	7.07	5.10	7.07	5.83	6.78	5.47	5.47	4.69	6.48	5.47

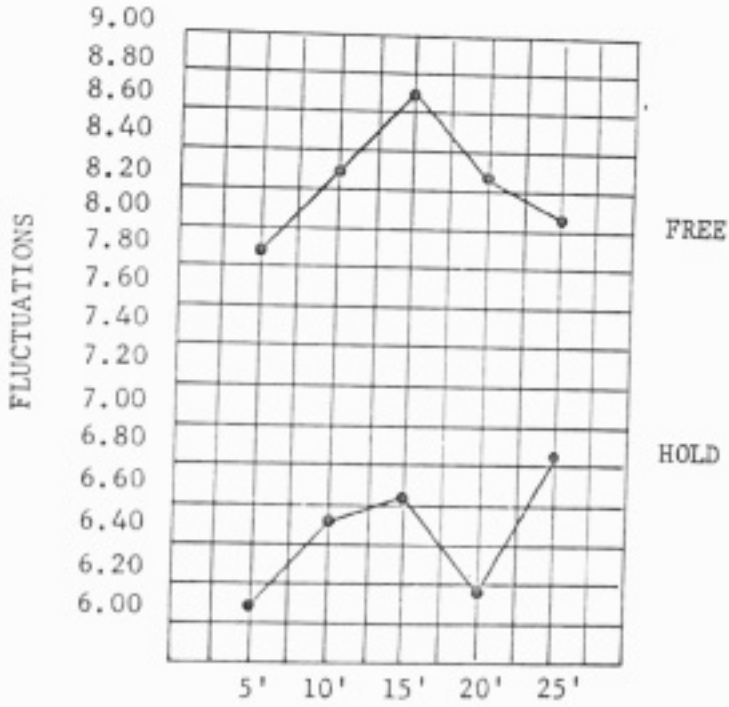

Figure 1. Wheatstone-Necker Fluctuation Rate Study. The Distance Times Instructions Interaction for the Women.

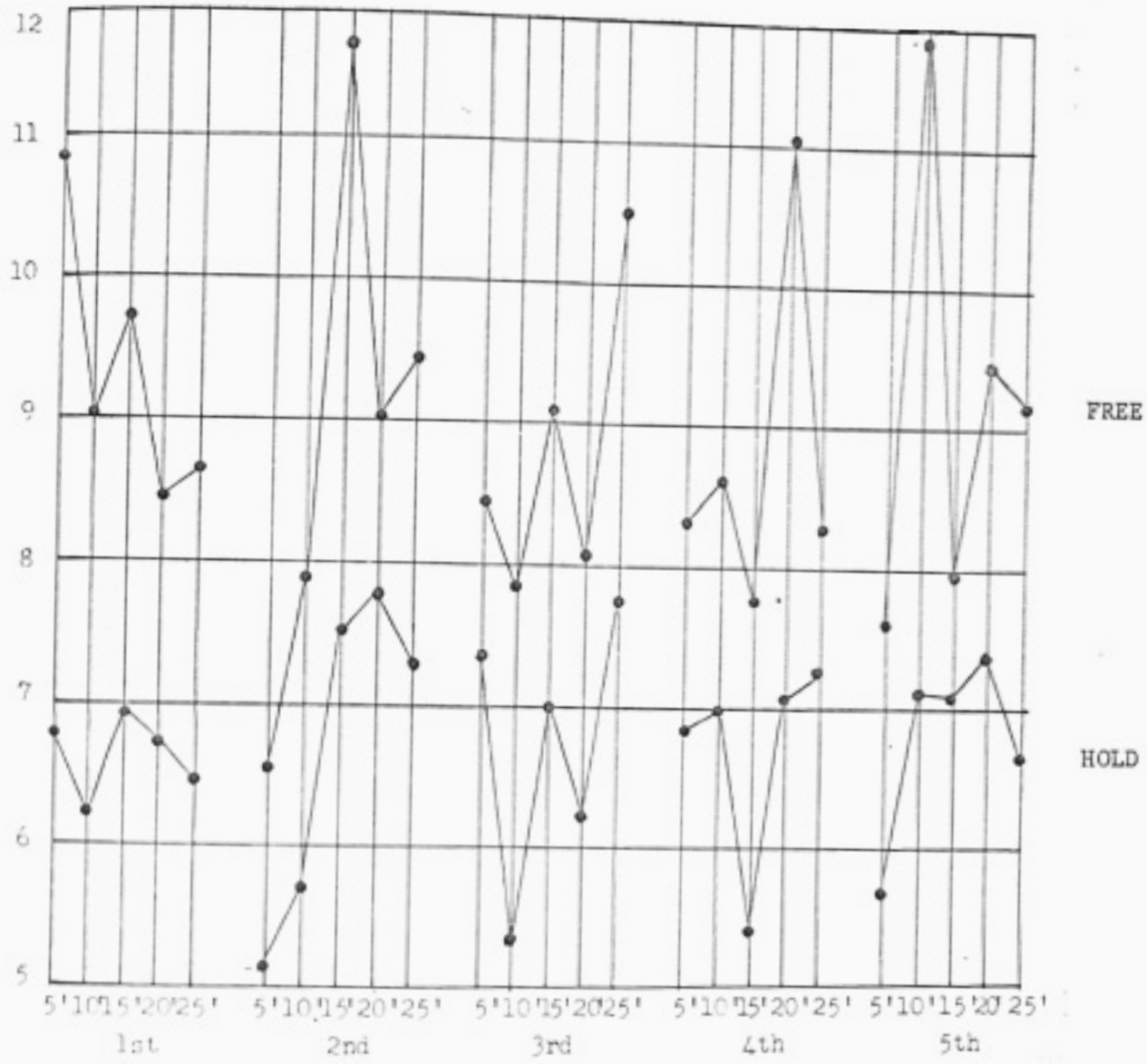

Figure 2. Wheatstone-Necker Fluctuation Rate Study. The Distance Times Learning Times Instruction Interaction for the Men.

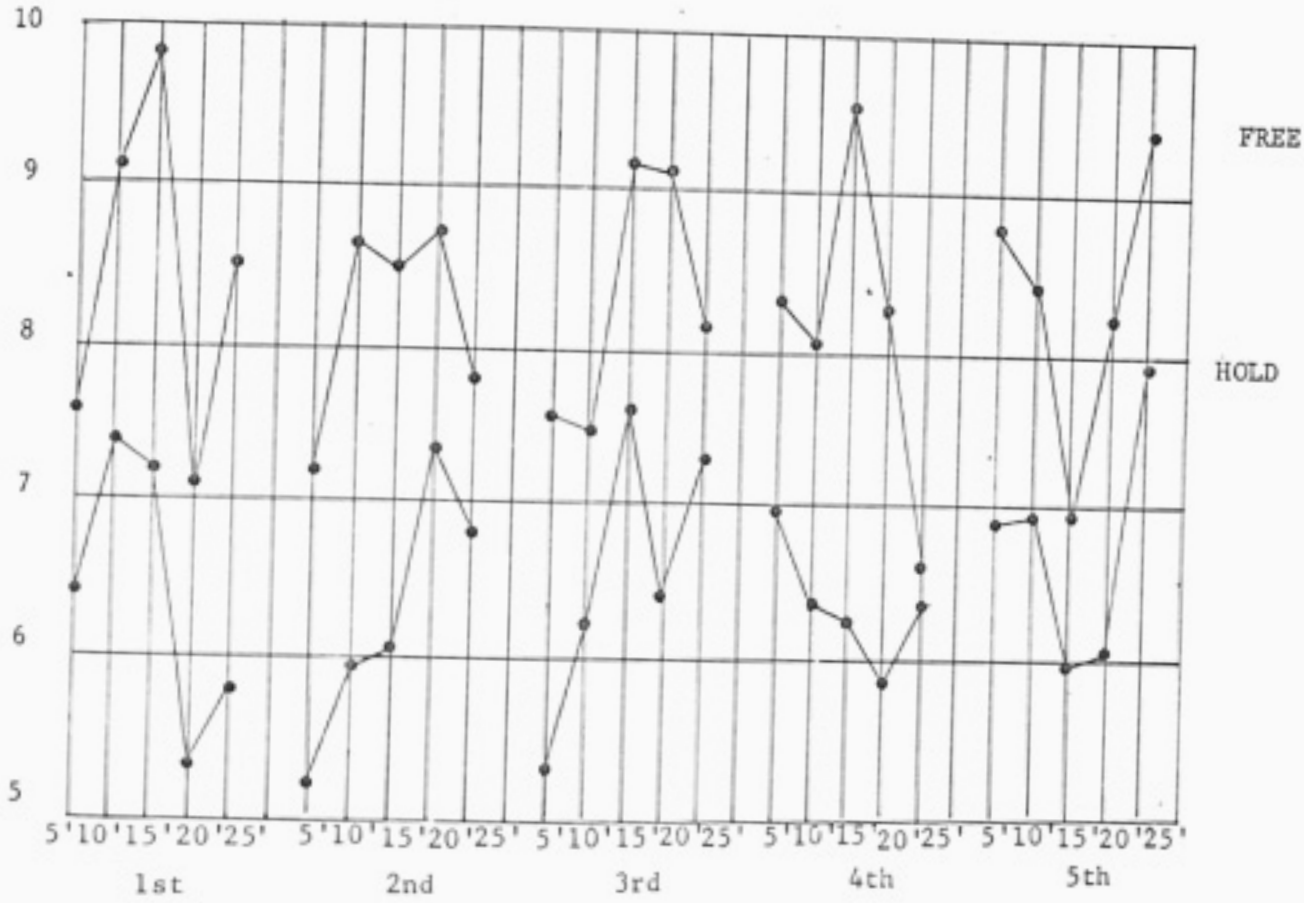

Figure 3. Wheatstone-Necker Fluctuation Rate Study. The Distance Times Learning Times Instruction Interaction for the Women.

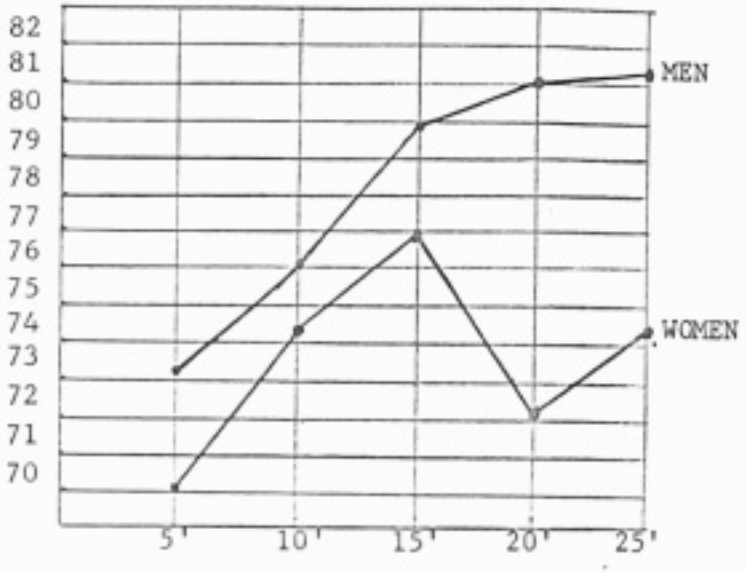

Figure 4. Wheatstone-Necker Fluctuation Rate Study. The Effect of Sex With Order and Instructions Combined.

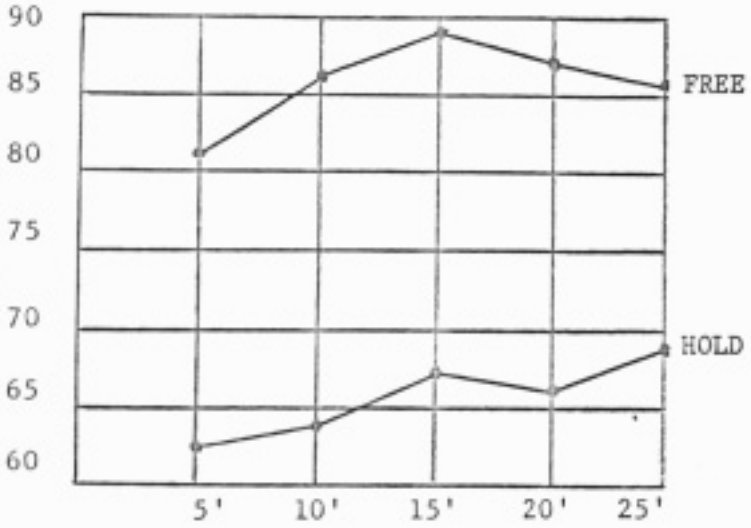

Figure 5. Wheatstone-Necker Fluctuation Rate Study. The Effect of Instructions with Sex and Order Combined.

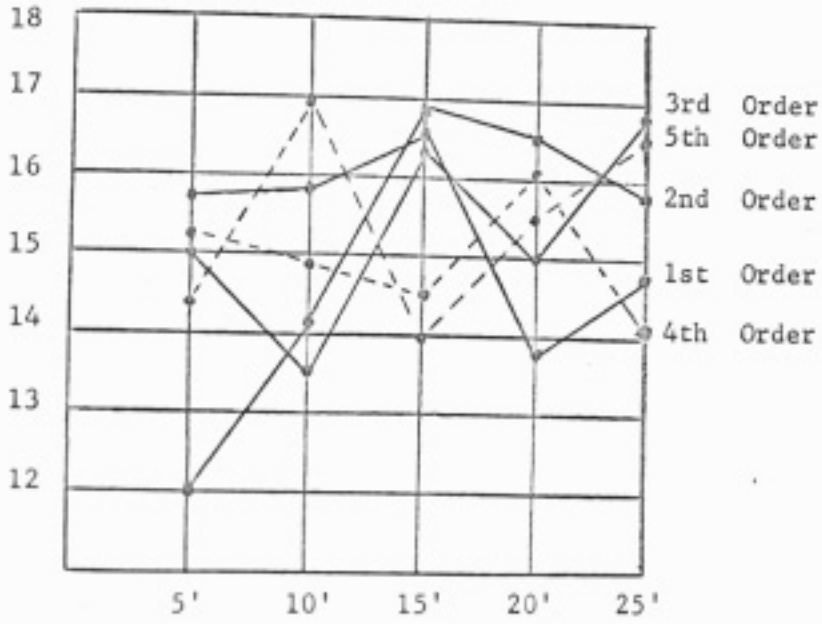

Figure 6. Wheatstone-Necker Fluctuation Rate Study. The Effect of Order with Instructions and Sex Combined.

times instructions (DxLxI) interaction is once more significant beyond the 1 per cent level. In addition another interaction, the distance times learning (DxL) interaction, is significant at the 5 per cent level.

Table V presents the distance times instructions (DxI) interaction means for the women. The trends of means for free and hold conditions across the five distances is significantly different and is illustrated in Figure 1.

Tables VI and VII and Figures 2 and 3 present means for the distance times learning times instruction (DxLxI) interaction. The figures indicate that the subjects function differently for some of the instructions and distances combined. The high significance of this interaction in both cases raises some questions concerning the appropriateness of the split-plot Latin-square design.

CHAPTER V

DISCUSSION

This experiment was an attempt to evaluate the roles of several stimuli on the number of reversals of a fluctuating figure. An attempt was made to assess the contributions of subjects, instructional set, distances, and the learning sequence. In an unpublished thesis at Drake University, Schuham[1] investigated some of these same variables but for the substitution of angle of view for distance. The design of Schuham's investigation randomized the sequence learning variable. It was felt that the control of the learning variable through a Latin-square design would allow some assessment of the effect of this variable in relation to the others.

For the males the results are fairly clear. Distance from the stimulus figure and instructions are significant. The plot of mean fluctuations versus distance indicated a curve which rises and then seems to level off. It is also clear that subjects can "take" instructional sets to let the cube fluctuate freely or to inhibit the fluctuations. The disturbing element in the analysis of the scores attained by the men is the significance of the distance by learning by instructions interaction. This is the highest order interaction in the analysis for the men and indicated that there are differences introduced

---

[1] A. Schuham, "The Effects of Angles of View and Instructions on the Fluctuations of Wheatstone-Necker Cube" (unpublished Master's thesis, Drake University, Des Moines, 1961).

at each of the distances by instruction and learning conditions not accounted for by these variables acting singly nor in simpler interactions. Such a finding tends to indicate that the refinement of technique has not advanced to a stage where full generalizations are possible. There would appear to be some uncontrolled variable causing these discrepant results. All the interpretations regarding the males must be modified to hold only for this group of subjects under these specific conditions.

The results for the women parallel those for the men with two exceptions. In addition to the significant findings in regard to distance, instructions, and the highest interaction, the distance times instructions interaction was also found to be significant. This would indicate that the women's scores would appear to be even more variable than those of the men. Whatever unknown factor is causing the additional variability in these two analyses, it would appear to operate stronger in the female subjects.

Despite the failure of the experimental design to achieve better "closure," the control of sequence does represent an improvement over the experimental design in which randomization did not permit an assessment of the strength of the sequence factor. The fairly large variation among the cells in the first tables, coupled with the significance of the highest order interactions in both of the analyses, would argue for the lack of control in some sequential factor. This view represents a guess in that the learning factor itself did not achieve significance in either of the analyses. The learning factor must therefore have been

balanced out among the other factors and shows up only in the highest interactions.

Probably the greatest amount of light could be shed on what is going on here by designing a sequence learning experiment and testing the results. Such a study would involve one standard viewing position, and five sequential counterbalanced trials. Separate groups of men and women subjects would be run in a straight repeated measurements block design. The learning sequence effect for both sets of instructions could then be studied clearly.

Certainly these "minor" factors need to be cleared up before the reversals of the fluctuating cube can be investigated with reference to environmental factors. Perhaps when these effects are known, a potent instrument for assessing personality differences might then be in the offing.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The effects of distance, instructional set, and learning-sequence on the number of fluctuations of the Wheatstone-Necker Cube were investigated. A number of controls derived from the experimental literature were incorporated into this investigation. Samples of both men and women subjects were run and their scores analyzed in separate split-plot Latin-square designs.

The distance and instructions variables and the distance by instructions by learning interactions were found to be significant for both analyses. In addition, a lesser order interaction, the distance by instructions interaction, was found to be significant for the women. Since the distance by instructions by learning interaction was the largest order interaction, the generalization of the findings was limited to these samples and to the conditions of the experiment.

An attempt was made to place the blame for the significance of the highest order interactions on the sequence learning factor despite the non-significance of this factor considered singly and in the simpler interactions. It was suggested that the effect of the learnings variable was randomized over the other variables and therefore showed up only in this highest interaction. Suggestions for experiments to check on this conjecture were made. It was also suggested that further investigations with fluctuating figures were blocked until the disturbing factor could be identified and effectively eliminated.

BIBLIOGRAPHY

BIBLIOGRAPHY

A. BOOKS

Boring, E. G. Sensation and Perception in the History of Experimental Psychology. New York: D. Appleton-Century Company, 1942.

Dixon, W. J., and F. J. Massey, Jr. Introduction to Statistical Analysis. Second edition. New York: McGraw Hill Book Company, 1957.

Lindquist, H. F. Design and Analysis of Experiments in Psychology and Education. Boston: Houghton Mifflin Company, 1953.

McDougall, W. Outline of Abnormal Psychology. New York: Scribner's and Sons, 1926.

Wimer, B. J. Statistical Principles in Experimental Design. New York: McGraw Hill Book Company, 1962.

Woodworth, R. S., and H. Schlosberg. Experimental Psychology. New York: Henry Holt and Company, 1956.

B. PERIODICALS

Bruner, J. S., L. Postman, and F. A. Mosteller. "Notes on the Measurement of Reversals of Perspective," Psychometrika, XV (1950), 63-72.

Flugel, J. C. "The Influence of Attention in Illusions of Reversible Perspective," British Journal of Psychology, V (1913), 357-397.

George, R. W. "The Significance of the Fluctuations Experienced in Observing Ambiguous Figures and in Binocular Rivalry," Journal of General Psychology, XV (1936), 39-61.

Glen, J. S. "Ocular Movements in Reversibility of Perspective," Journal of General Psychology, XXIII (1940), 243-281.

Guilford, J. P., and K. W. Braly. "An Experimental Test of McDougall's Theory of Extroversion-Introversion," Journal of Abnormal and Social Psychology, XXX (1931), 382-389.

Guilford, J. P., and N. O. Frederiksen. "Personality Traits and Fluctuations of the Outline Cube," American Journal of Psychology, XXXXVI (1934), 470-474.

Hoffeditz, E. L., and J. P. Guilford. "The Factors Present in the Fluctuations of Fifteen Ambiguous Phenomena," Psychology Bulletin, XXXII (1935), 726-727.

Hunt, J. McV., and J. P. Guilford. "Fluctuation of an Ambiguous Figure in Dementia Praecox and in Manic Depressive Patients," Journal of Abnormal and Social Psychology, XXVII (1932), 443-452.

Mull, H. K., K. Arp., and P. Carlin. "Indication of a Central Factor in Uncontrolled and Controlled Shifts in Cube Perspective," American Journal of Psychology, LXV (1952), 89-90.

Mull, H. K., N. Ord., and N. Locke. "The Effect of Two Brightness Factors upon the Rate of Fluctuation of Reversible Perspectives," American Journal of Psychology, LXVII (1954), 341-342.

Nemor, N. "The Alternation of an Ambiguous Figure in Paretics and Schizophrenics," Journal of Abnormal and Social Psychology, XXXXVIII (1953), 445-446.

Philpott, S. J. "Fluctuations in Human Output," British Journal of Psychology, XIV-XIX (1932), 5-125.

Washburn, M. F., and A. Gillette. "Motor Factors in Voluntary Control of Cube Perspective Fluctuations and Retinal Rivalry Fluctuations," American Journal of Psychology, XXXXV (1933), 315-319.

C. UNPUBLISHED MATERIALS

Schuham, A. "The Effects of Angles of View and Instructions on the Fluctuations of Wheatstone-Necker Cube." Unpublished Master's thesis, Drake University, Des Moines, 1961.